A New Vertex Fitter for the SNO Experiment

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The vertex fitter is one of the most important tools used in SNO data analyses. Position reconstruction can be critical in rejecting external backgrounds whose rates are normally several orders higher than that of neutrino-induced events.

All of the exsiting vertex fitters currently implemented in the SNO analysis code suffer from a common flaw: they are optimized according to Monte Carlo predictions. Normally MC simulations assume a perfect detector which is not always true in reality. For example, some PMTs in the detector are either malfunctional or poorly calibrated, thus they don't produce correct hit times of the detected photons. A couple of exsiting fitters use probability distribution functions produced by the MC in their maximal likelihood analyses.

Based on experience gained from the MC simulations and real data analyses, we designed a new vertex fitter. The main improvements of the new fitter are:

- A sliding time window is imposed before reconstruction to remove many mis-calibrated tubes and hits due to noise.
- Instead of using a normal Gaussian in the fitter, we use a truncated Gaussian as the p.d.f. The truncated Gaussian is much more robust against effects of bad hits.

Reconstructing the event direction is also important for neutrino data analyses as it enables us to deduce the origin of the neutrinos. Existing direction reconstruction algorithms are very simple. In our improved vertex fitter, we use a maximum likelihood method to determine the event direction which takes Cerenkov light emission into account.

We compared the results of the new fitter to that of the existing fitters on both the MC and real data produced by the ^{16}N calibration source. In both cases, the performance of the new fitter is better. Detailed report can be found in [1]. Figure 1 shows the results of the two fitters on the ^{16}N data: the upper plot shows results of the standard fitter where there are many mis-reconstructed events in the backward peak; the bottom plot shows results of the new fitter which managed to get rid of almost all events in the backward peak. We will continue to work on improving this new fitter so that it can be used in future analysis of SNO neutrino data.

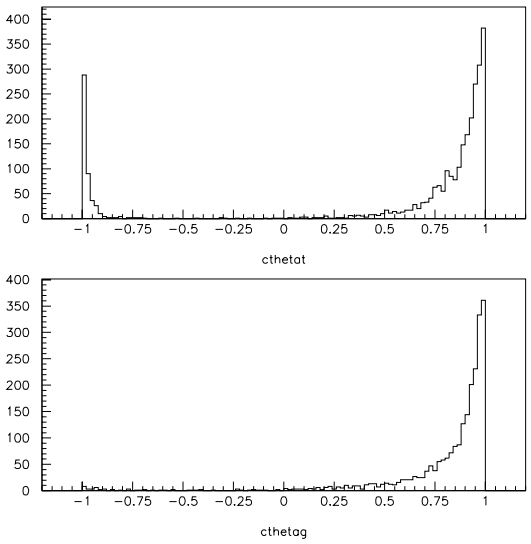

Figure 1: $Cos\theta$ distributions where θ is the angle between the fitted direction and the vector from the source position to the fitted event vertex.

References

[1] X.Chen; Miscellaneous Studies of ^{16}N Data, SNO-STR-99-018, 5/7/1999.